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A Bibliometric Review of Highly Cited and Hot Papers on Coronavirus and COVID 19

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Abstract

The main objective of the study is to identify and examine the characteristics of the highly cited and hot papers on Coronavirus and COVID 19. The distributions of highly cited and hot papers per year, country, organization and journal were analyzed, as well as authorship pattern and most frequently used keywords. The Web of Science (WOS) indexing database was selected to extract the bibliometric data of highly cited and hot papers on Coronavirus. Top cited and hot papers mainly originated from China, the United States, England, and Saudi Arabia and the majority were published from 2019 to 2020. The University of Hong Kong and Huazhong University of Science and Technology were leading organizations. Journal of Medical Virology,

the Lancet and The New England Journal of Medicine were top in publishing. Many of the publications have been contributed by multiple authors as compared to a single author. The frequently used keywords included acute respiratory syndrome, pneumonia, coronavirus, outbreak, infection, respiratory syndrome coronavirus, Severe acute respiratory syndrome coronavirus (SARS-CoV), and Middle East Respiratory Syndrome coronavirus (MERS-CoV). This bibliometric analysis of the highly cited articles on Coronavirus and COVID 19 from Web of Science has demonstrated several significant points, which help to map the progress on COVID 19 development and recent research trends and potentially guide Coronavirus researchers for evaluating and orienting their future research works.

Keywords**:** citation analysis, Coronavirus, COVID-19, highly cited articles, highly cited-COVID19

Introduction

The viral outbreak that started in Wuhan, China, in December 2019, has gripped the entire world. In March 2020, the World Health Organization (WHO) declared the outbreak to be a pandemic (Velavan & Meyer, 2020). To date, more than 6.3 million active cases worldwide with more than 758,322 deaths in 213 countries of the world (Worldometer, 2020).

The virus was identified to be an mRNA virus of the Coronavirus family (F. Wu et al., 2020) termed as COVID 19 by the WHO (Whitworth, 2020). An unrecognizable carrier state, high infectivity, and high mortality rates in the elderly have made it a public health problem of high priority (Shah, Ahmad, Choi, & Woo, 2020). The world has literally come to a standstill with billions of people under the lockdown and an impending economic recession (Normile, 2020). The search for prevention, treatment, and vaccination is going on, with little success so far (Yuen, Ye, Fung, Chan, & Jin, 2020). Clinical case reports are shedding light on clinical and diagnostic

features, while basic research is helping understand the genetic nature of the virus (Wu, Yang, Zeng, Wu, & Zhou, 2020). *In silico* models are helping project the structure of molecules that can be used for treatment as well as the production of antibodies and vaccines (Chen et al., 2020). The plasma of the recovered patients is also being tested for possible treatment of the sufferers (Shen et al., 2020). With many anti-inflammatory, antiviral and other modalities tried so far with little success, it is imperative to continue and monitor research in this urgent and important area of research.

With the ever increasing number of publications, bibliometric and other types of systematic analyses make it easy for scientists and policymakers to identify trends and set targets (Chuang, Chuang, Ho, & Ho, 2011). Bibliometric assessments are being carried out on diverse subjects in order to monitor the direction and productivity of a research policy or a field of science and help frame the relevant policies (Van Raan, 2003). It can help reset the direction of funding and priorities for acute as well as long-term policy changes. A bibliometric report that identifies highly cited papers, topics, and authors, highly productive institutions, and map their funding lays the foundation of a good review of the overall direction of research (Bornmann, Wagner, & Leydesdorff, 2015). This may be considered the first step towards an independent review of the details of the progress. In addition to policy makers, bibliometric studies also help younger scientists identify the publications with the most impact and set their future priorities and goals in line with the changes in the policies and funding in a specific field so that they might further the research works or develop new research directions based on these cornerstones (Schui & Krampen, 2010).

The scientific value of a research study is difficult to quantify. In addition to the impact factor, the number of citations that a particular study receives speaks not only about its credibility

and applications but also reproducibility in different scenarios (Glänzel & Moed, 2002). Of course, the impact of citation analysis offers an objective and cost-effective way of evaluating scientific performance. It is a standard measure of the academic impact of a research study in a specific field. It could provide a benchmark for quantification of the impact of research on international research progress (Bornmann, Mutz, Neuhaus, & Daniel, 2008).

In the same perspective, study by Laksham, Surulinathi, Balasubramani, and Srinivasaragavan (2020) merits a mention. The authors quantified the citation impact of open access research from Web of Science about subject of coronavirus carried out from 1989-2020 in the international perspective. They have summarized yearly increase in research publications, publication patterns, most productive organizations and countries as well as notable journals. They reported a total of 7381 publications from 127 different countries, with the highest number (561) published in 2019, that was cited a total of 848 times. They also noted that collaborative studies outnumbered those authored by one author. The study maintains that the top contributor to coronavirus research was the United States of America (USA) (2801 publications, 107738 citations, 37.9% of the total), adding that open access research articles can help spread the information quickly and encourage further research on the subject (Batooli & Sayyah, 2020).

A similar study by Almaghlouth et al. (2020) mapped coronavirus related published literature originating from Saudi Arabia. The study recorded 53 articles, predominantly opinion and narrative reviews about COVID-19 control and prevention of spread. The study identified lack of primary research about coronavirus in Saudi Arabia and highlighted its significance.

The current study was aimed at mapping the impact of research related to Coronavirus and COVID19 pandemic through citation analysis and identification of highly cited papers using Scientometrics techniques.

Research Questions

1. What are the publishing and citations trends of highly cited and hot papers?
2. Who are the most prolific authors, organizations, and countries?
3. What are the characteristics of Journals that published highly cited and hot papers?
4. What are the most influential articles on Coronavirus?
5. What are the authorship patterns of the highly cited and hot papers?
6. What are the most frequently used keywords of highly cited and hot papers?

Methodology

This study applied the bibliometric analysis method that focuses on the quantitative investigation of published academic work. The Web of Science (WOS) indexing database was selected to extract the bibliometric data of highly cited research articles on COVID-19. In the main search box of WOS core collection, the query was formed as "TS=(coronavirus* OR covid19 OR "covid 19" OR covid-19 OR ncov-* OR hcov-* OR sars-cov* OR " severe acute respiratory syndrome" OR mers-cov* OR "Middle East Respiratory Syndrome" OR "corona virus")" on July 18, 2020. A total of 34400 records appeared against the query. The results were then limited to highly cited in the field articles and hot papers in field; hence, the top-cited 296 articles' records appeared. So finally, 296 records including 228 original research articles and 68 review articles were considered. Highly cited papers in WoS are the papers published in last 10 years that remained in the top 1% based on number of citations received when compared to other peer papers published in the same field in the same duration of time (Clarivate Analytical, 2020). Hot Papers are papers published in the last two years that are receiving citations quickly after publication. These papers have been cited enough times in the most recent bimonthly period to place them in the top 0.1% when compared to papers in the same field and added to the database

in the same period (Clarivate Analytical, 2020). The data files were exported, and analyses were performed using VOS viewer, Cite Space software, and MS Excel spreadsheet. The researchers also used SCOPUS and Google Scholar (GS) citations scores to elaborate on the comprehensive impact of selected highly cited articles on Coronavirus.

Data Analysis

Year-Wise Publications and Citations

The publishing time period of the highly cited 296 articles included in the study fell between the years 2010 to 2020 (Table 1). The years 2020 and 2019 are the years with highest number of publications, (203 and 20 publications respectively). The year 2020 stood out as the most useful in respect of citations in all three major databases, WOS (29959 citations), Scopus (39935 citations), and Google Scholar (119114 citations). Comparatively, the year 2010 was the least productive year with only one publication.

Table 1. Yearly publishing trend and citations for the highly cited articles related to coronavirus from 2010 to 2020.

Year	Total Publication	WOS Citations	GS Citations	Scopus Citations
2020	203	29959	119114	39935
2019	20	962	2990	1192
2013	15	5159	8974	5415
2015	11	2141	3363	2140
2018	10	786	1853	897
2014	10	2047	3429	2197
2017	8	754	1476	800
2016	8	1480	3354	1673
2012	7	3188	5496	3449
2011	3	1074	1742	1131
2010	1	386	538	399

WoS: Web of Science GS: Google scholar.

Most Prolific Authors

The top ten authors in the highly cited 296 publications are highlighted in table 2. The table indicates the authors' current affiliation, number of publications, and citation scores in the top three indexing databases. Most of the authors on the list have produced five or more publications and have almost over 1000 citations in each indexing databases except the three authors at the bottom of the list.

Table 2. Top ten authors with respect to the number of publications in the highly cited articles on coronavirus with their affiliation and citation score.

Author	Affiliation	TP	WOS Citations	GS Citations	Scopus Citations
Drosten, Christian	Charité Universitätsmedizin Berlin	12	2507	7661	3324
Memish, Ziad A.	Research Centre, King Saud Medical City, Ministry of Health, Riyadh, Saudi Arabia	8	1987	4218	2140
Baric, Ralph S.	University of North Carolina	8	912	2577	1288
Haagmans, Bart L.	Erasmus MC, Viroscience Lab, Rotterdam, Netherlands	7	2209	4803	2686
Mueller, Marcel A.	Charité Universitätsmedizin Berlin	6	1822	5177	2264
Daszak, Peter	EcoHealth Alliance, USA	6	1381	2677	1550
Al-Tawfiq, Jaffar A.	Hopkins Aramco Healthcare, Dhahran, Saudi Arabia	5	1281	2343	1353
Corman, Victor M.	Charité Universitätsmedizin Berlin	5	982	3153	1287
Du, Lanying	Lindsley F. Kimball Research Institute, New York Blood Center, New York, USA	5	171	656	265
Kim, Jin Yong	Department of Internal Medicine, Incheon Medical Center, Incheon, Korea.	5	158	545	188

The top author *Drosten C.* has produced 12 publications and received 2507 citations in WOS, 3324 citations in Scopus, and 7661 citations in Google Scholar, followed by *Memish ZA* with eight (8) publications, 1987 WOS citations, 2140 Scopus citation and 4218 GS citation. Though on the 4th rank, the author *Haagmans, Bart L* got more than 2200 citations in all three databases.

Bibliographic Coupling of Authors Association

Bibliographic coupling is a method of establishing link between publications that indicates when two works cite the same third work. In VOS software, it specifies the number of cited references two publications have in common (Eck & Waltman, 2019). A minimum of four (4) documents of an author with a minimum number of 100 citations are selected in VOS to extract bibliographic coupling links with other authors. Hence, out of 2053 total authors, 24 met the thresholds that were combined in four clusters based on fractional counting methodology, a method in which all cite the same publication and the maximum combined score of any article is one (Figure 1).

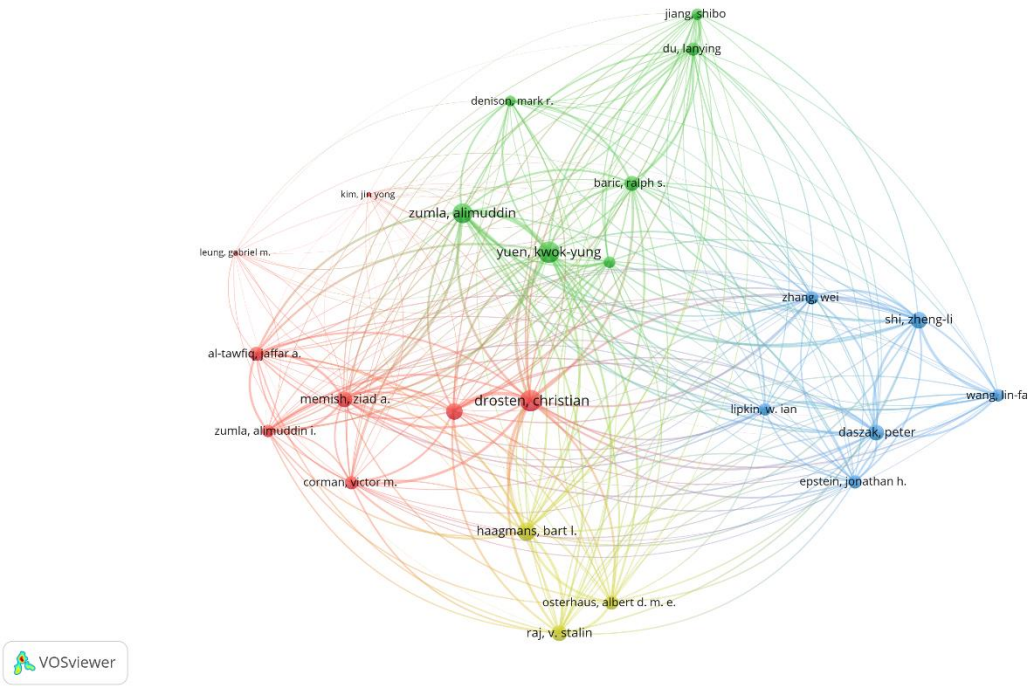

Figure 1. Clusters of bibliographic coupling of authors' association generated by tracking the combined citing of a work by two works. The publications meeting the inclusion threshold of minimum number of four documents of an author with a minimum number of 100 citations were found to be 24 and are divided in four clusters based on [fractional counting methodology].

The distance and size of the bubble show the associational link with other authors. Each color (red, blue, green and yellow) represents the separate cluster. The cluster 1 in red color consists of seven (7) authors including on *Drosten C, Memish Z, Zumla A, Al-Tawfiq J,Corman Victor and Kim G.* The cluster 2 in green color consists of six (6) authors including *Yuen KY, Zumla A, Baric R, Du Layning and Jiang Shibo.* The 3rd cluster in blue color consisted of five authors *that included Daszak P, Lipkin W, Wang J, Shi Z, Zhang W.* Finally, the 4th cluster in yellow-color consisted of three authors incuding *Haagmans B, Osterhaus A and Raj V.*

Highly Productive Publishing Countries

Most productive authors affiliated publishing countries data in the top 296 articles are placed in table 3. There are two countries that produced over 100 publications. China is on the top of the list with remarkable 143 publications and 27481 WoS citations, 36043 Scopus citations, and 99807 Google Scholar citations followed by USA with 104 publications, England with 33 publications, Saudi Arabia with 30 publications, the Canada, Germany, Italy and Neitherland with 20 publications each. France and Singapore are at the bottom of the list with 17 and 13 publications respectively.

Table 3. The top ten countries ranked based on number of publications contributed to the highly cited 296 articles about coronavirus included in the study and their citation scores in three databases.

Country	TP	WOS Citations	GS Citations	Scopus Citations
China	143	27481	99807	36043
USA	104	13956	36202	16120
England	33	5330	14773	6302
Saudia Arabia	30	6881	13310	7509
Canada	20	2196	6235	2473
Germany	20	3385	9937	4362
Italy	20	1105	4578	1239
Netherlands	20	4716	10368	5474
France	17	1581	5314	2059
Singapore	13	1342	3938	1631

TP: Total publications; WoS: Web of Science; GS: Google scholar.

Core Journals

The top ten journals that the highly cited 296 articles were published highlighted in table 4. There are four journals that produced more than 10 publications. The Journal of Medical Virology is top of the list with eighteen (18) publications and 1066 citations in WoS, 1532 citations in Scopus, and 4028 citations in Google Scholar. The *Lancet* journal is on 2nd rank with 17 publications and the highest number of citations in all three databases (WOS=10229, Scopus= 13068, Google Scholar= 35150). The *New England Journal of Medicine* with 13 publications and second highest citations score as compared to the top journal. It is followed by Nature with 11 publications and good citations in all three databases. The three journals at the bottom of the list *Journal of Virology, Lancet Infectious Diseases and Science* have six publications each.

Table 4. The list of the top ten journals that published the greatest number of publications out of the 296 highly cited papers about the coronavirus included in this study and their citation scores in three databases.

Rank	Journal	TP	WOS Citations	GS Citations	Scopus Citations
1	Journal of Medical Virology	18	1066	4028	1532
2	Lancet	17	10229	35150	13068
3	New England Journal of Medicine	13	8273	25191	10341
4	Nature	11	4021	10673	4785
5	Eurosurveillance	9	650	3621	1022
6	Journal of Clinical Medicine	7	314	1371	
7	Emerging Microbes & Infections	6	344	1371	484
8	Journal of Virology	6	740	2111	969
9	Lancet Infectious Diseases	6	1476	3260	1667
10	Science	6	888	3293	692

TP: Total publications; WoS: Web of Science; GS: Google scholar.

Most Productive Organizations

The top ten most productive organizations' data revealed that the range of publications of the top ten organizations falls between the maximum 29 publications to a minimum of 10 publications (Table 5). It is interesting to observe that 6 out of 10 highly productive organization

belong to China. The *University of Hong Kong* and *Huazhong University of Science and Technology, China* are on the top organizations with 29 and 21 publications respectively. Wuhan University and Chinese Academy of Sciences are slightly below and published 17 and 16 articles respectively, however University of Hong Kong, Chinese Academy of Sciences and Huazhong University of Science and Technology have highest citation scores in all three databases. The three organizations at the bottom of the list (Ministry of Health, KSA, University College London and University of North Carolina) have equally 10 publications each.

Table 5. Most productive organizations and the countries they are situated in, ranked based on number of articles contributed to the 296 highly cited articles about coronavirus included in this study.

Sr.#	Organization	Country	TP	WOS Citations	GS Citations	Scopus Citations
1	University of Hong Kong	China	29	7017	24588	9181
2	Huazhong University of Science and Technology	China	21	6421	24169	8654
3	Wuhan University	China	17	5991	21536	7859
4	The Chinese Academy of Sciences	China	16	6608	22598	8530
5	Fudan University	China	14	1244	4885	1515
6	National Institute of Allergy and Infectious Diseases	United States	11	1737	5195	1673
7	Guangzhou Medical University	China	11	2039	7862	2790
8	Ministry of Health	Saudi Arabia	10	2357	4784	2548
9	University College London	England	10	2460	5211	2713

TP: Total publications; WoS: Web of Science; GS: Google scholar.

Bibliographic Coupling of Organizational Link

According to the criteria stated in Figure 1, the bibliographic coupling of organizational links with other organizations was performed (Figure 2). The criteria include a minimum number of three documents produced by an organization as well as a minimum number of 100 citations received by an organization. Out of 727 total organizations, 24 meet the thresholds, consisting of three clusters. Each cluster is represented by a separate color. Cluster 1 is in red-color consisting on 9 organizations including *Huazhong University of Science and Technology, Wuhan University,*

Capital Medical University, Guangzhou Medical University, Zhejiang Medical University, Shanghai Jiao Tong University. Sichuan University, Sun Yat-sen University and Fudan University. Cluster 2 is in green color consisted of seven organizations, including *Chinese Academy of Sciences, University of North Carolina, National Institute of Allergy and Infectious Diseases* (NIAID), *Erasmus University Medical Center. The Charité – Universitätsmedizin Berlin, The Institut Pasteur, EcoHealth Alliance* and *University of Washington.* Finally, cluster 3 is in blue color consisting of six organizations, including *University of Hong Kong, Ministry of Health Saudi Arabia, University of Toranto, Chinese University of Hong Kong, University College London* and *King Abdulaziz University.*

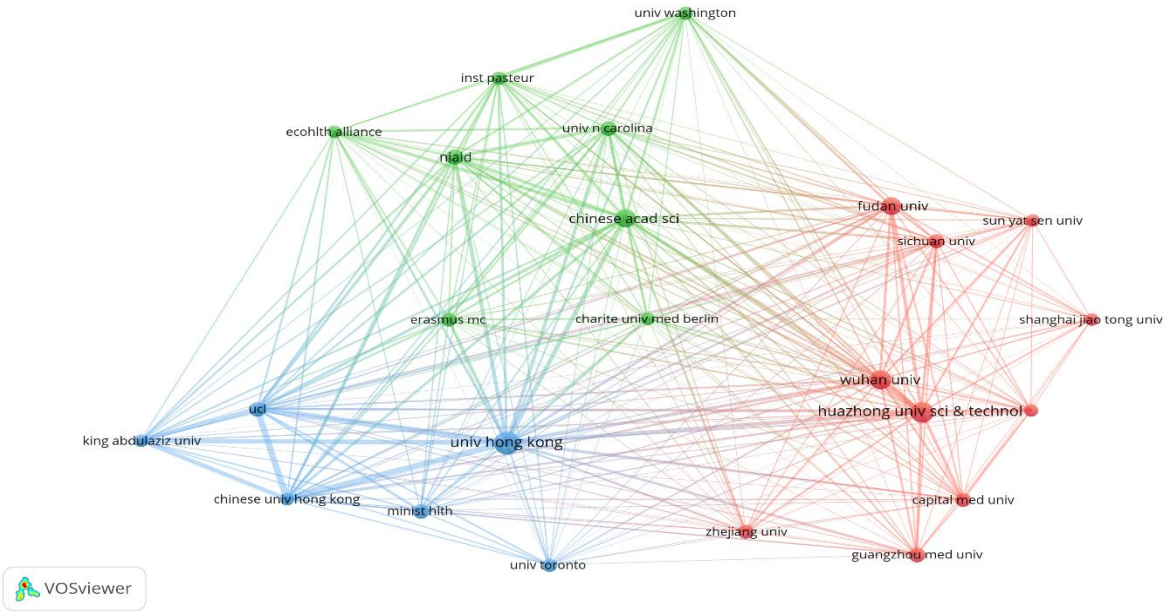

Figure 2. Bibliographic coupling of organizational link showing the 24 organizations in three clusters that met a threshold of minimum number of 3 documents and 100 citations out of the 296 highly cited articles on coronavirus included in the current study.

Authorship Pattern in Highly Cited Articles

The authorship pattern of highly cited 296 articles indicates the range of authorship from single-author to maximum sixty-seven authors (Figure 3). Apparently, the authorship pattern has

great variety and three, four, five, two and single author pattern is a frequent finding in the data. There are only few publications that have more than 23 authors.

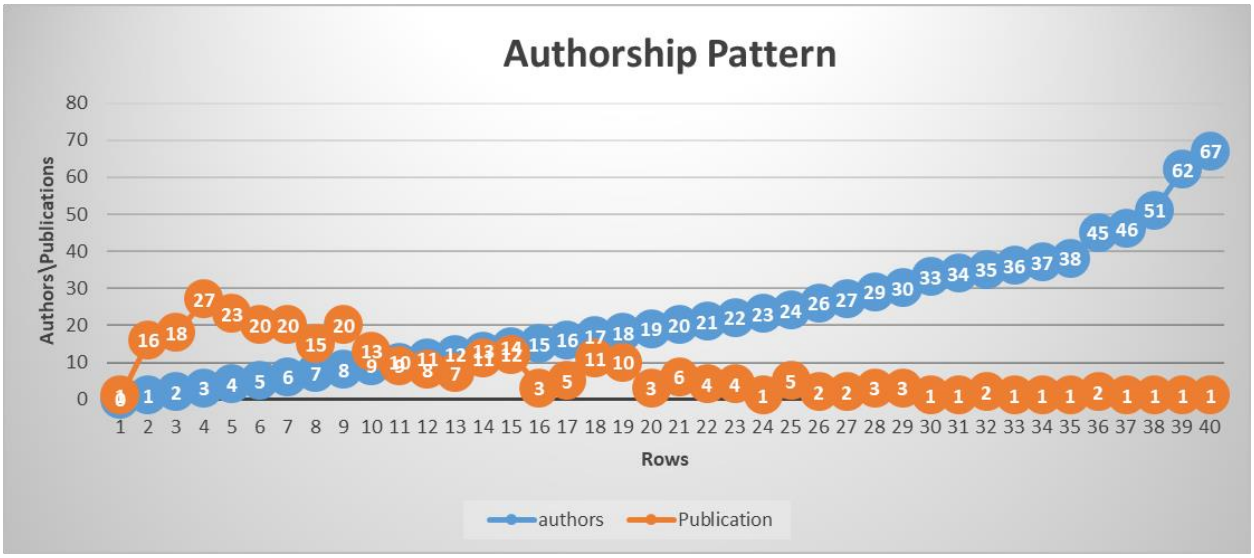

Figure 3. Authorship Pattern in the 296 highly cited articles on coronavirus included in the current study based on citations in the three databases. The number of authors varied inconsistently and most of the publications included more than 10 authors.

Top Ten Highly Cited Articles

The bibliographic information of the top ten most cited articles is indicated in table 6. The data revealed that the range of citations of top ten highly cited articles falls between the maximum 10036 citations (GS) to a minimum of 866 citations (WOS). It is worth mentioning that 8 out of 10 articles were published in The Lancet and New England Journal of Medicine. All 10 highly cited articles were published in four highest impact factor (IF=42 to 74) and Quartile one journals. The article entitled "Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China" by *Huang, Chaolin et al.* published (January 24, 2020) in *The Lancet* is on the top of the list with overall highest citations in all three indexing databases (2744 citations in WoS, 3615 citations in Scopus and 10036 citations in Google Scholar). This is followed by the article entitled "Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China" by *Dawei Wang et al* (1630 citations in WoS, 2118 citations in

Scopus and 5929 citations in Google Scholar) published in 2020 (Table 6). At the bottom of the list is the article authored by *Chan, JFW. et al.* published in 2020 with *Lancet* (866 citations in WoS, 1082 citations in Scopus and 3002 citations in Google Scholar).

Table 6. top 10 of the 296 highly cited articles on coronavirus selected on the citations in three databases.

Title	First Author	Source	Year	WoS Citations	GS Citations	Scopus Citations
Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China	Huang, CL	Lancet	2020	2744	10036	3615
Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China	Wang, DW	JAMA	2020	1630	5929	2118
Clinical Characteristics of Coronavirus Disease 2019 in China	Guan, W	New England Journal of Medicine	2020	1585	6078	2202
Isolation of a Novel Coronavirus from a Man with Pneumonia in Saudi Arabia	Zaki, AM	New England Journal of Medicine	2012	1576	2912	1715
Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study	Chen, NS	Lancet	2020	1467	5275	1866
A Novel Coronavirus from Patients with Pneumonia in China, 2019	Zhu, N	New England Journal of Medicine	2020	1465	5425	1981
Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study	Zhou, F	Lancet	2020	1094	4880	1578
A pneumonia outbreak associated with a new coronavirus of probable bat origin	Zhou, P	Nature	2020	1057	3888	1394
Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus-Infected Pneumonia	Li, Q	New England Journal of Medicine	2020	999	4804	1441
A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-	Chan, JFW	Lancet	2020	866	3002	1082

person transmission: a study of a family cluster

WoS: Web of Science; GS: Google scholar.

Keyword Plus Analysis

Keyword plus are the words generated automatically in the Web of Science from the titles of cited articles. Keyword plus analysis is performed in VOS software. The minimum number of 10 keywords occurrence is selected, and hence only 23 keywords meet the threshold out of a total of 705 keywords (Figure 4). The distance and size of the bubble indicate the frequency of keyword occurrences and associational links.

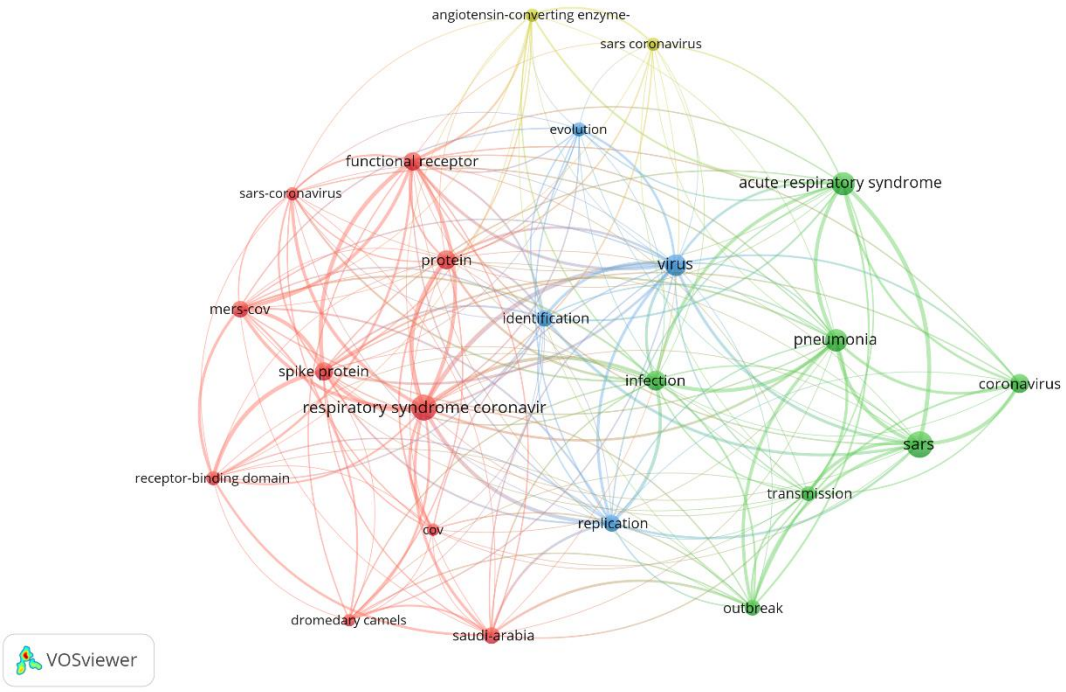

Figure 4. Keyword plus analysis generated through VOS software using the 23 keywords that met the threshold of inclusion (10 occurrence) to be most frequent in the 296 highly cited articles on coronavirus included in the study.

VOS has generated four clusters of these 23 keywords. Cluster-one (green) has six keywords, including acute respiratory syndrome, pneumonia, coronavirus, outbreak, infection. The second cluster (red) consisted on nine keywords including respiratory syndrome coronavirus, SARS

coronavirus (SARS-CoV), MERS CoV, spike protein, protein, dromedary camels, functional receptor, receptor-binding domain and Saudi-Arabia. The 3rd cluster (blue) consisted on four keywords including virus, evaluation, identification and replication.

Discussion

Bibliometric studies are being used increasingly to reveal trends and review progress in many research areas. The current study represents different dimensions of highly cited coronavirus research, including the top authors, organizations, countries, and journals. The analysis of data portrays publishing and citation trends over the years, the highly cited articles published between the years 2010 and 2020. The years 2020 and 2019 were at the top in producing highly cited articles, and the year 2020 showed more impact by receiving more citations than the year 2019. The data represent interesting findings regarding the years 2013 and 2012 that yielded less research but gained the attention of the researchers in the field. The year 2013 and 2012 received more citations from all three databases as compared to the remaining years. The study contradicts the findings of Laksham et al. (2020) who reported the highest number of scientific publications published in 2019, and the year 2004 as securing the highest number of citations. The difference may be attributed to a different search strategy and inclusion criteria.

The current bibliometric analysis of the highly cited articles ranked Drosten C., at the top position, who produced the maximum number of publications and also held the top position in terms of obtaining citations from the three studied indexing databases. Haagmans, Bart L., who was at the fourth position in the list in producing highly cited publications, received more citations in WoS and Scopus but fewer citations in Google Scholar than Mueller, Marcel A. who is at fifth position in producing highly cited research. Interestingly, all top seven authors achieved more than 1000 citations in three indexing databases. This shows a high degree of academic interest in the

subject of coronavirus during these years. A recent bibliometric study, although limited to most prolific authors on COVID-19 without measuring the citation impact, has reported top authors as Chen J. (n = 17), Li Y. (n = 17), Zhang L. (n = 15), Zhang Y. (n = 15), Li X. (n = 14), and Wang Y. (n=14) (Hossain, 2020). None of these authors were included in our study because of the timing of their publication (after the outbreak of COVID-19), and hence, a fewer number of citations received so far. Laksham et al. (2020) have, however, ranked Yuen KY at the top of the most productive authors based on the number of publications and citations received on the subject of COVID-19. On this criterion, this study ranked Drosten C. at number four.

Among the top ten countries producing highly cited articles on the topic, China led the way with a vast difference in terms of publications and citations received. The USA, with over 100 publications, received almost half citations in all three databases as compared to China. England and Saudi Arabia have a close competition regarding publications and citations received. Laksham et al. (2020) have conducted a bibliometric study on coronavirus extracting data from Web of Science multidisciplinary database from 1989 to 2020 (March), considering the open access publications only. The study ranked the USA on top with a total of 2801 publications and 107738 Citations, followed by China contributing a total of 1598 publications and 43600 Citations. Bonilla-Aldana et al. (2020) conducted a bibliometric study based on the Science Citation Index (SCI), Scopus, and PubMed databases using the term “Coronavirus” between January 1951 and January 2020. According to the findings of the study, the USA took the lead in producing scientific research on the topic, with nearly a third of the publications indexed in Scopus, PubMed, and SCI. The USA followed by China, maintaining the second position in producing publications in all the three studied indexing databases. The current study contradicting previous findings may be due to

a rapid change occurring in terms of publications and citations because of the focus of the researchers on the topic due to the current prevailing situation.

The analysis regarding the top ten journals that produced highly cited articles on Coronavirus found the Journal of Medical Virology, Lancet, and New England Journal of Medicine, maintaining the first three positions. Although the Journal of Medical Virology published a higher number of articles in the highly cited articles category (n=18), the Lancet received more citations as compared to all the journals in the list from all three indexing databases. New England Journal of Medicine securing third positions in terms of the number of publications also obtained more citations than the journal with highest number of publications in the list. Laksham et al. (2020) found the Journal of Virology as highly productive in producing 1120 publications on Coronavirus with 54882 citations in the study period followed by the journal Virology contributing 279 publications with 7917 citations. Apart from being cited in scientific literature, the social media aspect of scientific research has also come under the limelight owing to its huge informational and outreach impact. A recent study conducted by Batooli and Sayyah (2020) evaluated the social media attention gained by the scientific research related to COVID-19 over the period of four months of the pandemic. The study ranked the Lancet, Journal of Medical Virology, and Nature Reviews Drug Discovery as the journals producing the most discussed articles after the preprint services, i.e., MedRxiv, and BioRxiv. Studies with different inclusion criteria may be difficult to compare but the journals like Lancet and Nature have always been consistent in securing significant citations because of their wider and diverse audience.

The analysis regarding top organizations producing highly cited articles showed complete domination of organizations from China. Among top positions, China secured the first five positions, followed by one organization from the USA and the again seventh position maintained

by an organization from China. The University of Hong Kong is at the first position with a good margin from the remaining organizations in terms of publications but a close competition with the Huazhong University of Science and Technology in terms of the number of citations from all three databases. Remaining organizations appeared to be in tough competition with each other in producing publications and received citations. Laksham et al. (2020) also reported the University of Hong Kong, China, as a top organization with the highest numbers of publications (374) with 18554 Citations. The same study reported the Chinese Academy of Sciences contributing 217 publications with 6437 Citations followed by the University of Utrecht from Netherland, producing 199 publications with 9735 Citations at second and third positions, respectively. The apparent shift in research publication numbers to China can be explained based on the recent outbreak of COVID19 reported from Wuhan, China.

The individual analysis of the highly cited articles showed some interesting results. The article “Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China” by Huang, CL published in Lancet, in 2020, secured more citations than all other articles in the list with a clear margin in all three indexing databases. The analysis presents some interesting findings that all the top articles except “Isolation of a Novel Coronavirus from a Man with Pneumonia in Saudi Arabia” by Zaki, AM were published in 2020. It shows that the articles even published in the current years attracted the researchers in a very short span of time. All the articles in the list obtained over 1000 citations except the last two in the list that obtained less than 1000 citations from WoS. Batooli and Sayyah (2020) further reported the highly cited articles indexed in WOS, Scopus, and PubMed during the four months of the study period. Among these articles “Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China ” was at the top of the list with 472 citations published by the Lancet, followed by “A Novel Coronavirus from Patients

with Pneumonia in China, 2019 ” with 343 citations published by New England Journal of Medicine. Laksham et al. (2020) disclosed the most highly cited articles in their study period, i.e., “A novel coronavirus associated with severe acute respiratory Syndrome” published by New England Journal of Medicine obtained 1844 citations followed by “Identification of a novel coronavirus in patients with severe acute respiratory syndrome” published by New England Journal of Medicine with 1756 citations and ranked the article, “Isolation of a Novel Coronavirus from a Man with Pneumonia in Saudi Arabia ” by Zaki, AM at position five which the current study ranked at number four position.

The analysis regarding authorship patterns showed variation in the number of authors ranging from single to sixty-seven-authors. It is interesting to note that more than half of the articles were the collaboration ranging from single to ten researchers. Original research is mostly work of large groups that frequently involves collaborating teams based across borders contributing different aspects of experimental work. This is consistent with the findings of previous reports by Laksham et al. (2020) that describe multi-authored studies to outnumber single-author ones. Our study also reports that keywords bearing reference to MERS-CoV 2012 epidemic such as Saudi Arabia and dromedary camels dominated the figures in addition to the more usual keywords.

Our study reports important and unique aspects of highly cited research on coronavirus. The fact that studies related to MERS-CoV outbreak of 2012 have gathered a high number of citations is understandable given the fact that enough time has passed since their publication. The interest in coronavirus has never faded. The recent outbreak of COVID-19 will also generate valuable research, and future studies will be needed to see if the publication, authorship, and citation trends remain the same or not.

Conclusion

The current bibliometric study analyzed the highly cited articles on the Coronavirus and COVID19 pandemic. This study unfolds the publishing trends, and citations of highly cited articles, the most productive authors, organizations, journals, authorship, and collaborative patterns along with most frequently used keywords in the 296 articles identified as highly cited published between the years 2010 and 2020. The years 2020 and 2019 produced highest number of highly cited articles, and the years 2020 also secured most citations. The study ranked Drosten C., at the top position, who produced the maximum number of publications and also found at the top in securing the number of citations in all three studied databases. Most of the highly cited articles were published from China that led all the countries with a huge difference in terms of publications and citations as well. Chinese organizations remained dominant in producing highly cited articles, and the University of Hong Kong was the leading organization. Similarly, the top three journals, i.e., Journal of Medical Virology, Lancet, and New England Journal of Medicine, published most of the research on the topic. The research related to MERS-coronavirus outbreak of 2012 has also got significant attention. The study confirmed the findings of the previous research that the multiple authors contributed more research as compared to the single authorship pattern. Future studies will determine if the dynamics of research after COVID-19 remain the same or are different from them.

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